

obtained being 6054. The 11-inch Draper telescope has been employed for photographically recording the satellites of Jupiter undergoing eclipse, and variables of the Algol type. Mr. King, who has been investigating the effects of differential refraction and flexure on the form of the photographic images, has found that an equatorial should never be driven on sidereal time, but that satisfactory images have been obtained by photographing at suitable hour angles with a mean time driving clock, the rate being wholly corrected by the refraction in right ascension. Experiments are now being made to introduce a flexure correction automatically. In this connection it is interesting to refer to the work done by Dr. Rambeau. With regard to the other departments under the direction of Prof. Pickering, we must limit ourselves here to mentioning them: namely, the Boyden department at Arequipa, where the new Bruce photographic telescope has been erected, and the Blue Hill Observatory, although they have both been contributing valuable observations during the last twelve months.

THE NATURE AND HABITS OF PLINY'S SOLPUGA.

ALTHOUGH next to nothing is known of the past history of the spider-like creatures discussed in the following pages, it is tolerably certain that since glacial times they have been

of long-jointed limbs. Ælian, for example, tells how a country in Æthiopia was deserted on account of the appearance of incredible numbers of Scorpions and Phalangiums. But Pliny, when quoting the same story, introduces Solpuga¹ in place of Phalangium. And since the latter is now used in systematic zoology for a totally different group, namely for the so-called Harvest or Long-legged Spiders, so abundant throughout Europe, no further reason need be given for adopting Pliny's name for the species now under discussion.

So much by way of preface. But before leaving the ancient history of the Solpuga, it may be interesting to mention a suggestion that has been made to the effect that the Hebrew word translated Mouse in the Old Testament referred to some sort of Solpuga; and that the sores, the emerods (hæmorrhoids), from which the Philistines suffered, resulted from the bites of these creatures. In support of this supposition may be urged the unmistakable resemblance to mice presented by some of the smaller, dark-coloured, short-legged species, with their hairy bodies and rapid movements, which occur both in Egypt and Syria; and the statements of travellers to the effect that at the present time they inflict painful bites upon people when asleep in the desert at night.

It is beyond the scope of the present article to deal with the many points of interest connected with the anatomy of these animals. Nor is it necessary to point out all the distinctive features which serve to separate them from the true spiders, the only members of the class Arachnida with which they are likely to be confounded. Suffice it to say that the term spider, doubtless a corruption of spinner (spinster), is technically applied exclusively to the familiar web-spinners, and that no silk glands exist in any members of the order Solifugæ.

The general form is well shown in the annexed illustration depicting the male (Fig. 1) and the female (Fig. 2) of a North Indian species called *Galeodes fatalis*. As will be seen, the sexual differences are very striking, the male being both smaller and lighter in build, with the head narrower and the jaws less bulky; the legs, on the contrary, are unmistakably longer. This correlation between lightness of body and length of limb points to much greater activity on the part of the male, a superiority which no doubt stands him in good stead at the pairing time, when the female has a habit, it is alleged, of killing and devouring her less powerful mate. Again, in addition to being smaller, the jaws of the male (Fig. 1a) are always less strongly toothed than those of the female (Fig. 2a), and are furnished on the upper side with a peculiar organ of unknown function called the *flagellum*.

In both sexes, but especially in the female, the jaws attain a development unequalled elsewhere in the class Arachnida (Spiders, Scorpions, Solpugas, &c.). They are, in fact, admirably adapted for the purpose of crushing hard-shelled beetles and other insects. But they also have another duty to perform, namely, that of digging; for the females, at least

at the breeding season, excavate subterranean burrows for the protection of themselves and their young. The process has been observed in the case of the species here figured. Choosing a suitable spot, the female proceeded to cut away the earth in a circle with her jaws, then kicked away the loosened fragments with her legs, or scraping them together into a heap with the palpi [the long front pair of legs], pushed the pile by main force from the entrance of the burrow. At its opposite end the eggs, about fifty in number and resembling a mustard-seed in size and shape, were laid, and hatched about a fortnight afterwards. For

¹ This word is, perhaps, a corruption of *Solifuga* or *Solipugna*, which seem also to have been in use. The former means a creature which flees from the sun; the latter one that battles against it, and so hates or is intolerant of it.

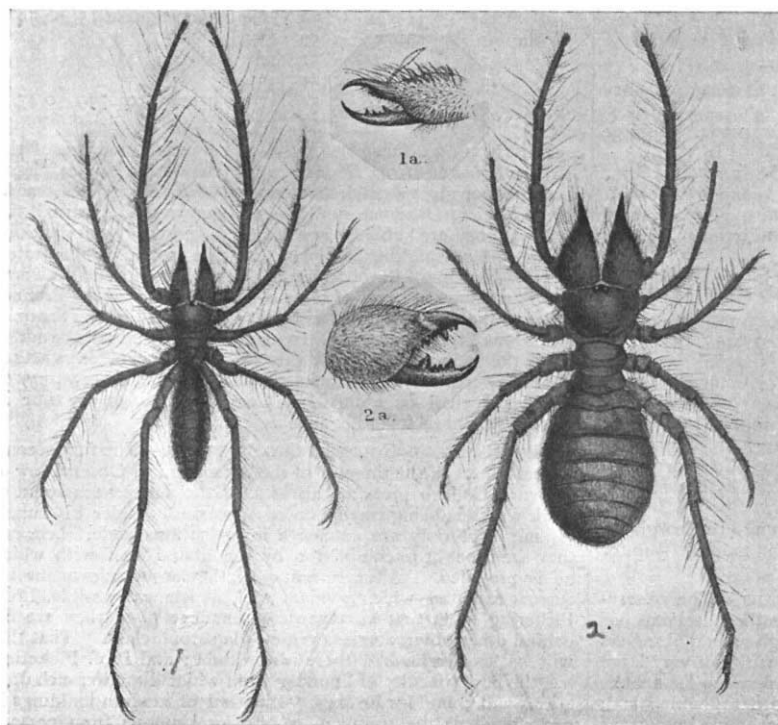


FIG. 1.—Indian Solpuga (*Galeodes fatalis*).—1, male; 1a, jaw of male seen from the side; 2, female; 2a, jaw of female seen from the side. (Figs. 1 and 2 reduced to three-fourths the natural size.)

confined in their distribution, so far as Europe is concerned, to Spain, Greece and South Russia. Since, therefore, they were certainly unknown to our British and Anglo-Saxon ancestors, and probably also to the early Romans, it is not surprising that the English language has no name for the group of which they are members. To the ordinary Englishman they are spiders, and as spiders or tarantulas they are usually described by travellers who have come across them in India, Egypt and elsewhere. The Greeks, on the contrary, who were doubtless acquainted with the species inhabiting their own country and Asia Minor, seem to have recognised them from the ordinary spider, since they had a distinctive name for each of the two groups. The spiders were called Arachne (*ἀράχνη*); the others Phalangium (*φαλάγγιον*), in allusion to their five pairs

three weeks the young showed no sign of movement. They then moulted for the first time and started to crawl about on their own account, little copies in miniature of their mother, who mounted guard at the entrance and resolutely repelled all intruders, snapping without hesitation at every object thrust into the burrow.

Some species of *Solpuga* are known to be diurnal, and have been met with roaming abroad in the full glare of the tropical sunshine. From this habit they are known to the Spaniards of Santiago as "Arañas del Sol" (sun-spiders). For the most part, however, they are nocturnal, and in certain localities favourable to their development prove a great nuisance to travellers camping out. Olivier, for example, describes how they would come into his tent in Mesopotamia at night, attracted by the light; and Mr. Guy Marshall informs me that an acquaintance of his, when encamped on the Hartley Hills, Mashonaland, was forced to shift his quarters on account of the invasion of his tent by a number of enormous spiders, evidently, from his description, a large *Solpuga*, which entered at night when the lamp was burning and rushed about at lightning speed. In such occurrences as these is doubtless to be found the substratum of truth upon which Ælian based his story of the desertion of the tract in Æthiopia on account of the Scorpions and Phalangiums.

Nothing in the way of animal life, provided it be of suitable size, comes amiss as food to the *Solpuga*, which is strictly carnivorous in diet. It is true that stories are told of the killing and eating of small vertebrates, like lizards, mice, birds, and bats. Nevertheless the staple article of their diet no doubt consists of insects of various kinds, ranging in size from ants to moths, beetles, or grasshoppers. A species which frequents the houses in Denver, Colorado, is said to be of service to mankind on account of its partiality for bed-bugs, a fact of some interest as showing that the strong stench of cyanide of potassium emitted by these parasites is no protection against the attacks of the *Solpuga*. Another kind living in Mashonaland, and known as *Solpuga sericea*—an elegant little species striped black and yellow, with long silky white hairs upon the hind legs, which, when running, resembles a tuft of thistle-down blown before the wind—feeds largely upon white ants; though Mr. Guy Marshall, my informant concerning its habits, has noticed that they eat jumping spiders of the family Attidæ, as well as small moths and beetles. When searching for food they may be seen running about at a great pace in the hot sunshine, and every now and again stopping to rest for a few seconds beneath the shade of a stone or leaf, only to rush off again without the least warning. Often when going at full speed they will stop abruptly and begin hunting and feeling around a small spot, irresistibly calling to mind the behaviour of a dog checked in mid-course by the scent of game. The white-ants they feed upon belong to a species which, instead of making a mound, builds mud tunnels along the surface of the ground amongst dead-leaves and sticks. Upon discovering such tunnelling the *Solpuga* follows it up, carefully examining it all the way, then suddenly breaks through the mud-wall and extracts a white ant. But whether the proximity of the insect is discovered by hearing or scent is at present unknown. This species is an expert climber, and has been seen to ascend trees to some height above the ground in search of prey. Similar stories are told of the climbing powers of other species from different parts of the world; and Mr. A. Carter informs me that in Egypt it is no uncommon thing to see a *Solpuga* (*Galeodes arabs*) climbing on to a table to get at the flies. To capture such quick and wary insects the *Solpuga* adopts the tactics of the hunting-spider; instead of making a furious dart, as it would if the prey in sight were a beetle, it proceeds to stalk the flies in the most wary fashion, creeping towards them with such slowness and stealth that the movements of the legs are almost imperceptible, yet all the while drawing gradually nearer and nearer; then like a flash of light the intervening space is traversed, and the insect struck down and captured.

Even in the case of so redoubtable an adversary as a scorpion, there is no hesitation on the part of the *Solpuga* in advancing to the attack. J. G. Wood tells us how at the outset of one such encounter the *Solpuga* by good fortune severed at one snap the scorpion's sting, and made short work of him afterwards. Nevertheless such an end to the contest is the exception rather than the rule; for in addition to some evidence on this head supplied by Mr. Trimen, Mr. Carter informs me that he has repeatedly witnessed encounters in Egypt between the common *Solpuga*

(*G. arabs*) and the sand-scorpion of that country (*Buthus quinque-striatus*); but though the two are well matched for size, the scorpions never came off second best, in spite of the incomparable advantage in point of activity enjoyed by their adversaries.

Striking is the difference in appearance between a *Solpuga* fasting and a *Solpuga* full fed. In the former the abdomen shrivels up, the segments shrinking one within another like the several pieces of a half-closed telescope; in the latter the expansion is carried to such an extent that the distended abdomen much resembles a short thick sausage, far surpassing in size and weight the rest of the body and limbs. This is brought about by the imbibition of water and of the fluid and semi-fluid tissues of their prey. In support of their water-drinking propensities, the following passage, written by the Soudan war correspondent to the *Standard* (October 19, 1897), may be cited: "One day in my tent [at Kerma] I heard a rustle like that of a silk dress. A big, ugly, yellow hairy beast, with nippers like a crab, was moving fast as a mouse over the moist ground near the zeer [porous water jar] in the corner of my tent. At last he settled down to suck the water from the sides of the jar." The writer of the passage just quoted had previously spoken of this animal as the "famous abu-shabat, the terror of the Soudan in the way of spiders, as large as your hand and ten times more venomous than a scorpion."

This question of the poisonous nature of the *Solpuga*'s bite is one that has attracted much attention. There is no doubt, however, that in the strict sense of the word they are not venomous at all. Nevertheless the jaws of the larger species are capable of giving a nasty and painful bite, and it is intelligible that a severe sore of long duration might result from such a wound if the *Solpuga* had been previously feeding upon septic matter, or if the sufferer were at the time addicted to scurvy or were in a weak state of health from any other cause. This, quite apart from other reasons, is sufficient explanation of the fact that the native inhabitants of almost all the countries where these animals are found look upon them with horror and fear on account of their alleged ferocity and venom. The natives of Somaliland, however, seem to be an exception to the general rule, for although the *Solpugas* are remarkable for size and abundance in that country, the Somalis, writes Mr. Parkinson, do not regard them as noxious, and have no names for things so unimportant. The dwellers in Baku on the Caspian, on the contrary, declare the Falangé [*Galeodes araneoides*] to be especially poisonous after emerging from its winter sleep, and, according to Mr. Rowland, believe that to counteract the effects of the poison it is necessary to rub the wound with the carcase of the *Solpuga* after first steeping it in boiling oil. Perhaps it is needless to explain to those who know the Asiatic that our subjects in Hindostan are firmly convinced of the deadly nature of the Jerry-manglum.¹ The opinion of these people on such a matter, however, is of no great value, as the following circumstance shows. Mr. H. R. P. Carter, when living at Madras, repeatedly, as he tells me, allowed the *Solpuga*, in the presence of natives, to bite his arm until the blood ran, without suffering anything worse than a passing pain from the wound. But although his experiments proved conclusively to himself the harmlessness of the bite, they were not sufficient to make the onlookers alter their judgment one whit. In confirmation of Mr. Carter's conclusion it may be added that Mr. J. Ffolliott Darling has also had the fortitude to make similar experiments on himself, and has attained similar results, with species that are found in South Africa.

Of their enemies we know but little. From an observation made by Mr. Distant, who, while in the Transvaal, saw a wag-tail attacking a specimen of *Solpuga hostilis*, a small species which is abundant in that country and in Natal, it may be inferred that they are eaten by insectivorous birds, and probably also by some mammals and reptiles. So, too, may it be supposed that the larger kinds of *Solpuga* destroy the smaller, and that all, both great and small, fall victims to large and medium-sized scorpions, to say nothing of great spiders and carnivorous ground beetles, many of which would certainly be powerful enough to overcome the weaker species.

It must be remembered, too, that although when fasting their agility is amazing, and their chances of escape correspondingly great, yet when gorged with food, as described above, and practically unable to trail their distended bodies behind them,

¹ This name for the *Solpuga* in the Tamil language I venture to spell as I have heard it pronounced.

they would fall easy victims to enemies much weaker and slower than themselves.

On the other hand, we learn from Dufour that the species found in Algeria are exempt from the attacks of the Mason wasps, which, as is well known, in that and in all countries fearlessly attack and destroy numbers of the largest spiders, and could, without difficulty, catch the fleetest *Solpuga* in the world. The reason for this freedom from persecution is not quite clear, unless it is to be explained by the fact that the *Solpuga* is too formidable a foe for the wasp to tackle. That this may well be the case is rendered intelligible by the reflection that the large lycosiform and mygaloid spiders fall easy victims because, owing to feebleness of vision and lack of activity, they are not quick enough to elude the final swoop of the wasp. The *Solpugas*, on the other hand, as compared with the spiders, are exceedingly agile and keen-sighted. Moreover, when on the defence, they have a habit, as described by Dr. Walter, of turning up the abdomen, so as to protect that vulnerable part, and extending the legs forwards and upwards in such a way as to present to the foe a pair of gaping jaws surmounted by five pairs of strong limbs armed with long bristles, stout spines and sharp claws. Small wonder if under the circumstances the wasps think discretion the better part of valour.

The last peculiarity to be mentioned is the presence on the inner surface of the jaws of some strong horny ridges, which by mutual friction emit a harsh grating noise. In some genera these ridges are scarcely at all developed: in others they are very pronounced. That the sound is produced in the way described under the stimulus of sudden fear or irritation was long ago pointed out by Hutton, and even before him by Pallas; and, touching its function, one can only suppose that, like analogous organs found in the rattlesnake and in some of the largest spiders and scorpions, it acts as an advertisement of the whereabouts of the *Solpuga*, and as a warning to enemies to keep a respectful distance.

R. I. Pocock.

THE LABOULBENIACEÆ: A NEW FIELD OF STUDY AMONG FUNGI.

THE knowledge of most botanists of the group of Fungi here under treatment is probably confined to the brief description given of them by De Bary, under the head of "Doubtful Ascomycetes," where Peyritsch's figures of *Stigmatomyces Baeri* are reproduced.

Since 1884, when De Bary's "Fungi" appeared, the investigation of the group has, however, proceeded apace; and whereas at that time hardly more than a dozen species had been distinguished, Dr. Thaxter considers that no fewer than 150 species belonging to 30 genera are now known. Almost all of these additions are due to Dr. Thaxter's investigations, and have already been announced, from time to time, in a series of papers emanating from the Cryptogamic Laboratory of Harvard University.

The first to observe one of these Fungi was probably the entomologist Laboulbène, in whose honour *Laboulbenia rougetii* was named by Montagne and C. Robin. The earliest description came from Robin in the "Histoire Naturelle des Végétaux Parasites" in 1853. H. Karsten (1869) and Peyritsch (1871-75) followed with a more detailed treatment of the morphological characters of the group, and still later Berlese, Giard, Istvanffi, and Thaxter, have in turn added to our knowledge of the family.

The Laboulbeniaceæ are, without exception, entomogenous, and occur upon species of beetles and flies almost exclusively. They are attached to the chitin of the insect by only a minute foot, by means of which, however, they absorb all the nutriment they require for their development. Upon examination with a hand-lens, they have the appearance of hairs or bristles of a dark colour, standing out vertically from the substratum. As they seldom exceed half a millimetre in length, it is not surprising that they easily escape the notice of entomologist and mycologist alike.

Their morphological characters present features of unusual interest, inasmuch as they seem to exhibit a marked sexuality, and that of a peculiar type. The male cells are non-motile spermatia, arising for the most part endogenously, but in

certain genera abstricted exogenously, as in the case of the Floridææ. These spermatia become attached to trichogynes, whose cell-wall appears to have the same gelatinous consistence as have those of the Floridææ. In some genera, these trichogynes become branched and multicellular; in a few cases they bend over to come into contact with spermatia *in situ*, and then straighten again, carrying off a detached spermatium. Bearing the trichogyne is a "trichophore," itself resting on a "carpogenous" cell. From this latter there are ultimately budded off four or eight asci, each containing, when mature, four or eight usually septate ascospores, the whole being enclosed in a fusiform fructification, recalling the perithecium of a Pyrenomycete. It seems impossible to resist the impression that the asci arise as the result of an act of fertilisation, though the details of the process have not been observed. That the Laboulbeniaceæ are to be included among Ascomycetes can no longer be doubtful, and their morphology, when considered in connection with the observations of De Bary, Janczewski, Stahl, and more recently Harper, lend support to the view that sexuality persists in this class of Fungi. It is difficult to imagine how otherwise Brefeld can account for the structure of Laboulbeniaceæ, when his researches have extended thus far.

The similarity in the method of fertilisation with that existing in Floridææ is very marked. For the occurrence of a receptive trichogyne and detached non-motile spermatia among Fungi, Stahl's observations had already prepared us, though it has been denied that the structures called by these names in Collema, have the sexual significance they have been shown to have in Floridææ. The analogy of the similar organs in Laboulbeniaceæ with those of Floridææ would seem to be beyond doubt. A further startling analogy with Floridææ is found in the occurrence of a single conspicuous pit in the walls separating successive cells of the hyphæ; and, as in Floridææ, these have already been utilised in tracing the genetic connection of the cells of the thallus. Although Thaxter, on account of these similarities, does not regard the derivation of Laboulbeniaceæ from Floridææ, as unworthy of consideration, it is improbable that they indicate anything more than similarities of adaptation, which often occur in widely separated groups.

Of the 250 different species of insects on which these Fungi have been found parasitic, 241 are Coleoptera, and of these the majority are aquatic or riparian in habit. Of the 7 dipterous host-species one is the common house-fly, which is frequently infested with *Stigmatomyces Baeri* in the neighbourhood of Vienna. The single termite affected came from Africa, and the single acarid from Paraguay. Though most of the Laboulbeniaceæ yet described are exclusively North American, 19 European species are known, and some accompany their hosts into two or three continents. It is probable that the family will be found to be numerous in species, and widely distributed in range. No British locality for a single species is given in Dr. Thaxter's work, and no British writer seems to have yet made any contribution to the literature of the group. In Dr. Cooke's "Vegetable Wasps and Plant Worms," published in 1892, the species then described by Thaxter and others are enumerated, but no discovery of any of these in Britain seems to have been known to the author. It is highly improbable, however, that none of the parasites occur on any of the more than 3000 British species of Coleoptera.

Though these plants do not at present appear likely to become of any economic importance, yet it is clear that they are of exceptional morphological and physiological interest; and Prof. Thaxter has earned our gratitude for the persistence with which he has pursued their study, and for the ability and skill with which he has described and portrayed them. The work forms a worthy successor to the author's monograph on "The Entomophthoræ of the United States."

R. W. P.

THE BOLOMETER.¹

IN the number of the *American Journal of Science* for March 1881, there appeared an article descriptive of the actinic balance (since called the Bolometer), an instrument which has gained acceptance among physicists as a useful aid in the study of radiant heat. It was, it may be remembered, originally devised by the writer to discriminate the heat in any small portion of the grating spectrum, but it has since found wider applications.

¹ Reprinted from the *American Journal of Science*, April. (Communicated by the Author.)

¹ "Contributions toward a Monograph of the Laboulbeniaceæ." By Roland Thaxter. (*Memoirs of the American Academy of Arts and Sciences*, vol. xii. No. 3, December 1896. Pp. 242, pls. 26.)